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(54) **Title:** LOCATION-BASED RECONFIGURATION OF INFUSION PUMP SETTINGS

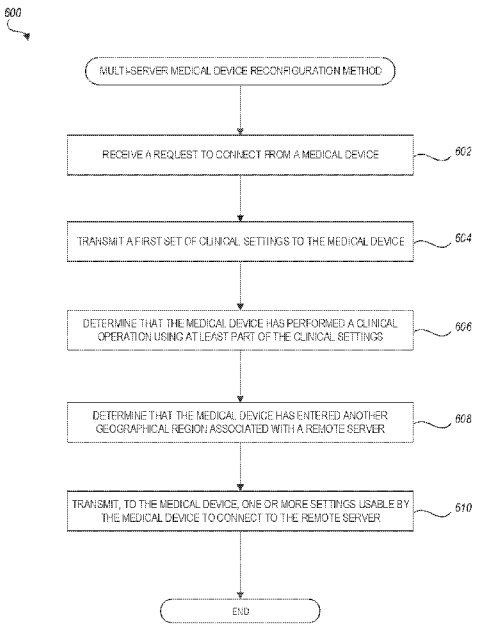

FIG. 6

(57) **Abstract:** A system configured to reconfigure the settings on a medical device based on a detected location of the medical device is provided. The system may include a server configured to receive a connection request from a medical device, update the settings on the medical device, determine that the medical device has entered another geographical area, and transmit, to the medical device, additional settings that can be used to connect to another server configured to communicate with medical devices in said another geographical area.

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LOCATION-BASED RECONFIGURATION OF INFUSION PUMP SETTINGS

INCORPORATION BY REFERENCE TO ANY PRIORITY APPLICATIONS

[0001A] This application claims priority to Indian Patent Application No. 202011028208, filed on July 2, 2020 and titled "LOCATION-BASED RECONFIGURATION OF INFUSION PUMP SETTINGS," and U.S. Provisional Application No. 63/068,798, filed on August 21, 2020 and titled "LOCATION-BASED RECONFIGURATION OF INFUSION PUMP SETTINGS," the disclosures of which are incorporated herein by reference in their entirety. Any and all applications for which a foreign or domestic priority claim is identified in the Application Data Sheet as filed with the present application are hereby incorporated herein by reference in their entirety under 37 CFR 1.57.

TECHNICAL FIELD

[0001B] This disclosure relates to the field of medical devices, and particularly to techniques for reconfiguring a medical device based on detection of change in the location of the medical device.

BACKGROUND

[0002] Medical devices capable of performing various clinical operations are commonplace in modern hospital environments. Such medical devices may connect to a hospital network using predetermined network settings and communicate with other devices on the hospital network. Such medical devices may also store rules that govern the clinical operations available on the medical devices to improve patient safety.

SUMMARY

[0003] Various techniques for updating the settings on a medical device based on the location of the medical device are described herein. Although many of the examples are described in the context of a hospital environment, the techniques described herein can be applied to any environment in which medical devices can operate. The medical devices described herein may be infusion pumps, other medical devices, or any combinations thereof. The settings described herein may be network settings, infusion settings, drug library settings, other medical device settings, or any combinations thereof. For example, an infusion pump can be moved across different rooms and clinical care areas (CCAs) within a hospital, or even to

different hospitals. As the location of the infusion pump changes, the settings on the infusion pump may need to be updated (e.g., for proper network connectivity, date update, and compliance with safety standards, and the like).

[0004] According to embodiments of the present disclosure, the settings of a medical device may be re-configured or otherwise changed upon detecting that the medical device has entered a designated area, exited a designated area, or both. These and other embodiments are described in greater detail below with reference to **FIGS. 1-7**.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The embodiments described herein are illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings in which like references indicate similar elements.

[0006] **FIG. 1** is a schematic diagram of an example hospital environment including one or more medical devices in accordance with aspects of this disclosure.

[0007] **FIG. 2** is a block diagram illustrating components of an example hospital environment in accordance with aspects of the present disclosure.

[0008] **FIG. 3** is a block diagram illustrating a general architecture of an example medical device in accordance with aspects of this disclosure.

[0009] **FIG. 4** a block diagram illustrating movement of a medical device across geographical areas in an example hospital environment in accordance with aspects of this disclosure.

[0010] **FIG. 5** is a process flow diagram illustrating the interactions among various components in an example hospital environment in accordance with aspects of this disclosure.

[0011] **FIG. 6** is a flow chart illustrating an example multi-server medical device reconfiguration method in accordance with aspects of this disclosure.

[0012] **FIG. 7** is a flow chart illustrating an example single-server medical device reconfiguration method in accordance with aspects of this disclosure.

DETAILED DESCRIPTION

Introduction

[0013] A hospital environment may include medical devices, such as infusion pumps, that are mobile and moved to and from different areas of the hospital environment. The hospital environment may be a hospital having a central server that communicates with the

medical devices within the hospital. Such medical devices may need to be connected to the central server via a wired or wireless connection to perform their clinical operations (e.g., an infusion pump may initiate infusion therapies on patients in response to instructions from the central server).

[0014] The hospital environment described herein may include a single hospital building, a multi-building hospital facility, or a multi-facility hospital network. The buildings and/or facilities may be close to each other or spread out over multiple cities, states, countries, etc., and may belong to a single entity or enterprise or belong to different entities or enterprises.

[0015] When a medical device is moved from one area to another, the settings stored on the medical device may need to be updated. For example, the network settings on the medical device may need to be updated so that the medical device can access the network in the new area (e.g., the Wi-Fi network) and communicate with the correct server in the new area to receive clinical commands (e.g., a command to start an infusion therapy). As another example, the safety settings on the medical device may need to be updated so that the medical device is in compliance with the safety protocols in the new area (especially if the new area has stricter safety standards), for example, to allow fewer drug types, stricter limits on volume infused, and the like. One method of updating the settings stored on the medical device is for a biomedical engineer to manually reconfigure the settings on the medical device when the medical device is first moved into the new area. However, such a method requires notifying the biomedical engineer of the change in the location of the medical device and ensuring that the biomedical engineer is available to update the settings on the medical device, which would consume a significant amount of human resources. Further, such a method may not be sufficiently responsive, especially in emergency situations.

[0016] Thus, an improved method of detecting a change in the location of a medical device and reconfiguring the settings on the medical device is desired.

[0017] With reference to **FIG. 1**, an example hospital environment in which one or more of the medical device reconfiguration techniques of the present disclosure may be utilized is described. Following the discussion of **FIG. 1**, specific details of the various embodiments of the present disclosure are described with reference to **FIGS. 2-7**.

Overview of Example Hospital Environment

[0018] **FIG. 1** illustrates one embodiment of a system for administering medication via an infusion pump in a hospital environment 100. The medication management system (MMS) shown in **FIG. 1** includes a medication management unit (MMU) server 3108 and a medical device, such as infusion pump 3130, operating in conjunction with one or more information systems or components of a hospital environment.

[0019] Intravenous (IV) fluid(s) and/or medication(s) 3100 in containers 3102 may be administered to a patient 3104 using the system shown in **FIG. 1**. Although the system shown in **FIG. 1** utilizes barcodes and a barcode reader as apparatus to input and read machine-readable information, those skilled in the art will appreciate that other apparatus for reading or inputting information may be utilized. Moreover, a point of care (POC) client 3126 may include an identification receiver 32 adapted to recognize such indicia may be provided in the MMS.

[0020] In certain aspects, the IV fluids and/or medications 3100 in container 3102 may be provided with new or supplemental labels with a unique infusion order identifying barcode by a pharmacist according to certain hospital practices. Specifically, drug container specific identification information, such as barcoded information on the container 3102 may include patient identification information, medication identification information, universal identification information, medical device delivery information, and/or medication order information. The IV fluids and/or medications 3100 in barcode-identified containers 3102 may be supplied to hospitals by various vendors, with preexisting unique barcode identifiers, which include medication information and other information, such as a National Disease Center (NDC) code, expiration information, drug interaction information, and the like.

[0021] In some aspects of the disclosure, the universal identification information on the container 3102 may be a unique medication order identifier that, by itself, identifies the order associated with the container. In other aspects, the identification information on the container 3102 may be a composite patient/order code that contains both a patient ID (such as a medical record number) and an order ID unique only within the context of the patient. In certain aspects, the identification information on the container 3102 may include a medication ID. The system identified in **FIG. 1** may include a drug library editor (DLE) client 3106, such as a notebook, desktop or server computer. The DLE client 3106 may include DLE software. As described above, the MMU server 3108 may have MMU software that is installed and runs on the MMU server 3108. The drug library and other databases may be stored on the MMU server 3108, on a separate server, and/or in remote locations.

[0022] Hospital information systems (HIS) 3110 may include one or more computers connected by cabling, interfaces, and/or Ethernet connections. Alternatively, wireless connections and communications may be used in whole or in part. Servers provide processing capability and memory for storage of data and various application programs or modules, including but not limited to an admissions-discharge-and-transfer (ADT) module or computer 3112, a computerized physician order entry (CPOE) module or computer 3114, and a pharmacy information system (PIS) module or computer 3116. Hospital personnel, such as admission clerks 3118, physicians 3120, and pharmacists 3122, respectively, may be authorized to access these modules through client workstations connected to the servers in order to enter data, access information, run reports, and complete other tasks.

[0023] In the embodiment shown in **FIG. 1**, the HIS 3110 may also include a POC system 3125 including a server or POC computer 3124 (sometimes referred to as a barcode point of care server or computer), or the POC computer 3124 may be separate from the HIS 3110. The POC computer 3124 may act as a part of the POC system 3125 (sometimes referred to as the barcode point of care system or BPOC) and may be able to wirelessly communicate through a plurality of wireless communication nodes located throughout the hospital, utilizing a wireless communications protocol, such as IEEE 801.11, IEEE 802.11, or Bluetooth. The POC computer 3124 may communicate wirelessly with a portable thick client, POC client 3126, carried by a caregiver. The POC client 3126 may be a personal digital assistant (PDA) that includes significant memory, display, and processing capabilities. The POC client device may execute a variety of programs stored in its memory in some degree independently of the POC computer 3124.

[0024] In one embodiment of **FIG. 1**, the MMU server 3108 may be hard-wired to the DLE client 3106 and to a MMU client 3128. Alternatively, the MMU and DLE client functions may be combined onto a single client computer/workstation or may reside together with the MMU server 3108 on a single combined MMU/DLE server. The MMU server 3108 may reside in a location remote from the patient's room or treatment area. For instance, the MMU server 3108 may reside in a secure, climate controlled information technology room with other hospital servers, and computer equipment and its client terminals may be located in the pharmacy, biomedical engineering area, nurse station, or ward monitoring area. One MMU server 3108 may monitor, coordinate, and communicate with many infusion pumps 3130. For example, in one embodiment, the MMU software running on the MMU server 3108 may support up to one thousand infusion pumps concurrently.

[0025] In embodiment of **FIG. 1**, the POC client 3126 in the POC system 3125 may communicate through the POC server 3124 with the MMU server 3108. The MMU server 3108 may interface or communicate wirelessly with the infusion pump 3130 through the same wireless nodes utilized by the POC system 3125 and a connectivity engine and antenna on or in the infusion pump 3130. Communication between the infusion pump 3130 and the POC client 3126 may take place through the MMU server 3108 and POC server 3124. The MMU server 3108 may store in an associated memory both the logical ID and the network ID or Internet Protocol (IP) address of the infusion pump(s) 3130, such that only the MMU server 3108 may communicate in a direct wireless manner with the infusion pump 3130. Alternatively, the MMU server 3108 may provide the IP address and other information about the infusion pump 3130 to the POC system 3125 to facilitate direct communication between the POC system 3125 and the infusion pump 3130.

[0026] Upon admission to the hospital, the admission clerk 3118 or similar personnel may enter demographic information about each patient 3104 into an associated memory of the ADT module or computer 3112 of an HIS database stored in an associated memory of the HIS 3110. Each patient 3104 may be issued a patient identification wristband, bracelet, or tag 112 that may include an identifier 3103, such as a barcode or RFID tag, identifying the patient. The wristband, bracelet, or tag 112 may also include other information, in machine readable or human-readable form, such as the name of the patient's doctor, blood type, allergies, and the like.

[0027] The patient's doctor 3120 may prescribe medical treatment by entering a medication order into the CPOE module or computer 3114 within the HIS 3110. The medication order may specify a start time, stop time, a range of allowable doses, physiological targets, route, and site of administration. In the case of an order for infusion of fluids or medication, the order may be written in various formats, and may include the patient's name, patient ID number, a unique medication order or prescription number, a medication name, medication concentration, a dose or dosage, frequency, and/or a time of desired delivery. This information may be entered into the memory of the CPOE module or computer 3114, and may be stored in a memory associated with at least the POC server 3124.

[0028] The medication order may also be delivered electronically to the PIS module or computer 3116 in the pharmacy and may be stored in an associated memory. The pharmacist 3122 may screen the prescribed order, translate it into an order for dispensing medication, and prepare the medication or fluids with the proper additives and/or necessary diluents. The pharmacist 3122 may prepare and affix a label 102 with drug container specific

identifying information 3101 to the medication or drug container 3102. The label may include in machine-readable and/or human-readable form medical device specific delivery information including but not limited to the dispense ID number, patient ID, drug name, drug concentration, container volume, volume-to-be-infused ("VTBI"), rate, duration, and the like. Only two of the three variables VTBI, rate, and duration may be defined as the third may be calculated when the other two are known. The labeled medication may be delivered to a secure, designated staging location or mobile drug cart on the ward or floor near the patient's room or treatment area. The medication order pending dispensing or administration may be posted to a task list in the HIS 3110 and POC system 3125 and stored in an associated memory.

[0029] The caregiver 3132 (e.g., a nurse) may use the identification receiver 32 associated with the POC client 3126 to scan his/her caregiver identification badge 116 and enter a password, which logs the caregiver into the system and authorizes the caregiver to access a nurse's task list from the POC system 3125 through the POC client 3126. The caregiver 3132 may view from the task list that IV drugs are to be administered to certain patients 3104 in certain rooms. The caregiver 3132 obtains the necessary supplies, including medications, from the pharmacy and/or a staging area in the vicinity of the patient's room.

[0030] The caregiver 3132 may take the supplies to a patient's bedside, turn on the infusion pump 3130, verify that the network connection icon on the infusion pump 3130 indicates a network connection (for example, a wireless connection such as Wi-Fi or the like) is present, select the appropriate clinical care area (CCA) on the infusion pump 3130, and mount the IV bag, container, or vial 3102 and any associated tube set as required in position relative to the patient 3104 and infusion pump 3130 for infusion. Another connection icon on the infusion pump 3130 or pump user interface screen can indicate that a wired or wireless connection to the MMU server 3108 is present. Using the identification receiver/reader integral to the POC client 3126, the caregiver 3132 may scan the barcode on the patient's identification wristband, bracelet, or tag 112 or other patient identification device. A task list associated with that particular patient may appear on the POC client 3126 screen. The task list, which may also include orders to give other forms of treatment or medication by other routes (oral, topical, etc.), may be obtained from the HIS 3110 via the POC server 3124 and communicated wirelessly to the POC client 3126. In one embodiment, the list is generated by matching the scanned patient ID with the patient ID for orders in memory within the POC server 3124. In another embodiment, the order information may be obtained by scanning the drug container specific identification information for associated orders in memory within the POC server 3124, through the following step(s).

[0031] The caregiver 3132 may scan the medication barcode label 102 containing medication container specific identification information 3101 on the medication container 3102 with the POC client 3126. The POC client 3126 may highlight the IV administration task on the task list and send the scanned medication container specific identification information, such as dispense ID information, from the medication container 3102, to the POC server 3124. The POC server may use the medication container specific identification information to pull together the rest of the order details and send them back to the POC client 3126. The POC client 3126 may then display an IV Documentation Form on its screen. One side of the IV Documentation Form screen may show the order details as "ordered" and the other side may be reserved for a status report from the infusion pump 3130. The status report from the infusion pump 3130 may be transmitted to the POC client 3126 through the POC server 3124 and MMU server 3108. The lower portion of the IV Documentation Form screen may provide the caregiver 3132 with instructions (like to scan the infusion pump 3130 barcode) or identify whether the pump is running or stopped.

[0032] The caregiver 3132 may then scan the barcode label 92 associated with the infusion pump 3130 (or pump channel if the pump is a multi-channel pump). The barcode label 92 may contain medical device specific identification information 3131, such as the logical name and/or logical address of the device or channel. The POC system 3125 then automatically bundles the information into a program pump request containing the "order details" and in one embodiment, without further interaction with the caregiver 3132, transmits this information to the MMU server 3108.

[0033] The program pump request may include at least some of the following information (in HIS/POC system format): a Transaction ID, which may include a Logical Pump ID, a Pump Compartment, a Pump Channel ID, a Reference Device Address, a Caregiver ID, a Caregiver Name, a Patient/Person ID (HIS identifier), a Patient Name, a Patient Birth Date & Time, a Patient Gender, a Patient Weight, a Patient Height, and an Encounter ID which may include a Room, a Bed, and a Building (including CCA). The program pump request may also include Order Information or "order details", including an Order ID, a Start Date/Time, a Stop Date/Time, a Route of Administration, a Rate, a Duration of Infusion (Infuse Over), a Total Volume to be Infused (VTBI), an Ad Hoc Order Indicator, and Ingredients including HIS Drug Name or HIS Generic Drug Name, HIS Drug Identifier or HIS Generic Drug ID, Rx Type (Additive or Base), Strength w/units, and Volume w/units. The program pump request may further include Patient Controlled Analgesia (PCA) Orders Only information, such a PCA Mode-PCA only, Continuous only, or PCA and Continuous, a Lockout Interval (in minutes), a

PCA Continuous Rate, a PCA Dose, a Loading Dose, a Dose Limit, a Dose Limit Time w/ units, a Total Volume in vial or syringe, and Order Comments.

[0034] The MMU server 3108 may map or convert the wide range of expressions of units allowed by the HIS 3110 or POC system 3125 for POC client 3126 requests into the much more limited set of units allowed in the MMU server 3108 and infusion pump 3130. For example, the POC client 3126 request may express "g, gm, gram, or grams" whereas the MMU server 3108 and/or infusion pump 3130 may accept "grams" only. Infusion pump 3130 delivery parameters or infusion pump 3130 settings are mapped or converted from corresponding order information or "order details" of the program pump request.

[0035] The MMU server 3108 may store in an associated memory a mapping or translation table that keep track of the logical ID, serial number or other identifier of an infusion pump 3130 and the corresponding current network (static or dynamic) address (Internet Protocol (IP) address) or ID of the infusion pump 3130 on the network, which in this example is a wireless network. The MMU server 3108 may be able to translate or associate a given identifier of the infusion pump 3130 with its network address in the translation table and provide the network IP address to the requesting POC system 3125 or device. The MMU server 3108 may also store in an associated memory and/or look up the drug library applicable to the scanned infusion pump 3130 and/or convert the Drug ID and Strength from the pump program request into an index number of the medication at the desired strength or concentration from the drug library. The duration of the infusion may come from the POC system 3125 in hours and minutes and may be converted to just minutes for the infusion pump 3130 to recognize it. Volume or VTBI may be rounded to provide a value-specific and infuser-specific number of digits to the right of the decimal point. Units (of drug) may be converted to million units where appropriate. Patient weight may be converted and either rounded according to infuser-specific rules or not sent to the infuser.

[0036] Once the MMU server 3108 transforms the information from the program pump request into infusion pump settings or delivery parameters and other information in a format acceptable to the infusion pump 3130, the MMU server 3108 may wirelessly download a command message to the infusion pump 3130. If the infusion pump 3130 is not already equipped with the latest appropriate version of the hospital-established drug library, the MMU server 3108 may also automatically download a drug library to the infusion pump 3130. The hospital-established drug library may be maintained in a separate process undertaken by the biomedical engineer or pharmacist 3122 to place limits on the programming of the infusion pump 3130, as well as other infusion pump operating parameters such as default alarm settings

for air in the line, occlusion pressure, and the like. The drug library may set up acceptable ranges or hard and/or soft limits for various drug delivery parameters in the infusion pump 3130.

[0037] The MMU server 3108 may also download to the infusion pump new versions, patches, or software updates of the infusion pump's internal operating system software. The infusion settings or delivery parameters and other information from the MMU server 3108 may be entered into the memory of the infusion pump 3130 and the infusion pump 3130 settings may automatically populate the programming screen(s) of the infusion pump 3130, just as if the caregiver 3132 had entered the information and settings manually. The infusion pump 3130 screen may populate with the name of the drug and drug concentration based on the drug library index number, patient weight, rate, VTBI, and/or duration. Further, the MMU server 3108 may detect that a new infusion pump has connected, determine whether the settings stored on the infusion pump are up to date, and/or transmit updated settings to the infusion pump as needed, as described in greater detail below with reference to **FIGS. 2-7**. A return message of confirmation signal may be sent to the MMU server 3108 by the infusion pump 3130 to indicate that the command message has been received. At this point, if necessary, the caregiver 3104 may manually enter any additional infusion settings or optional information that was not included in the command message.

[0038] The infusion pump 3130 may then prompt the caregiver 3132 to start the infusion pump 3130 by pressing the start button. When the caregiver 3132 presses the start button, a confirmation screen with the infusion settings programmed may be presented for confirmation and an auto-program acknowledgment message can be sent to the MMU server 3108 to forward without request (i.e., pushed in a near real-time manner) or provide to the POC system 3125 when requested or polled. When the caregiver 3132 presses the button to confirm, the infusion pump 3130 may begin delivering fluid according to the programmed settings. The infusion pump 3130 may send a status message to the MMU server 3108 indicating that the infusion pump 3130 was successfully auto-programmed, confirmed and started by the caregiver 3132, and is now delivering fluid. This information may also be displayed at the infusion pump. The MMU server 3108 may continue to receive logs and status messages wirelessly from the infusion pump 3130 periodically as the infusion progresses or when alarms occur.

[0039] The MMU server 3108 may report a portion of the initial status message to the POC client 3126 through the POC server 3124 (in MMU format) to indicate that the infusion pump 3130 has been auto-programmed and the caregiver 3132 has confirmed the

settings. The MMU server 3108 may communicate to the POC system 3125 and/or at the infusion pump 3130 the actual Rate, VTBI, and Duration. A notation at the bottom of the screen of the POC client and/or the infusion pump may indicate that the infusion pump 3130 is running. The infusion pump 3130 may compare and give a visual, audio, or other type of affirmative signal if the pump information matches or acceptably corresponds with the ordered information. An initial determination of whether the pump information matches the order may be done in the MMU server 3108 and communicated to the POC client 3126 through the POC server 3124. Alternatively, the POC server 3124 or the infusion pump 3130 may make the necessary comparisons. If the pump information does not match the order, the infusion pump 3130 at the display 88 may output a visual, audio, or other type of negative signal, which may include an error message.

[0040] The caregiver 3132 may be prompted to review and press a save button on the infusion pump 3130 if the order has been begun as desired or any variations are acceptable. The MMU server 3108 may receive status, event, differences, and variation information from the infusion pump 3130 and pass such information to the POC system 3125. In a separate subsequent step, the nurse may electronically sign the record and presses a send button on the POC client POC client 3126 to send the information to the patient's electronic medication record (EMR) or medication administration record (MAR).

Other Environments

[0041] **FIG. 1** illustrates one example environment in which the various medical device reconfiguration techniques of the present disclosure may be utilized. However, the embodiments described herein are not limited to such an environment, and may be applied to any network environment including one or more servers in which medical devices in different geographical regions use different sets of settings. An example system that may be implemented in one or more of such network environments to provide location-based medical device reconfiguration is described below with reference to **FIG. 2**.

System Overview

[0042] **FIG. 2** is a block diagram of an example hospital environment 200, which includes an arrangement of computer hardware and software components that may be used to implement aspects of the present disclosure. The hospital environment 200 may include many more (or fewer) elements and/or sub-elements than those shown in **FIG. 2**. It is not necessary, however, that all of these elements be shown in order to provide an enabling disclosure. As

illustrated in **FIG. 2**, the hospital environment 200 includes a location detection system 202, an enterprise server 203, a hospital server 206A, and a hospital server 206B connected to a network 204, and additionally, a medical device 208A in communication with the hospital server 206A, and a medical device 208B in communication with the hospital server 206B. Although only two hospital servers and two medical devices are shown in **FIG. 2**, the hospital environment 200 may, in some embodiments, include only a single hospital server or more than two hospital servers. Additionally or alternatively, one or more of the hospital servers in the hospital environment 200 may include two or more medical devices.

Location Detection System

[0043] The location detection system 202 may use Global Navigation Satellite System (GNSS), such as Global Positioning System (GPS) or GLONASS navigation system, for geo-spatial positioning, and/or non-GNSS technologies such as Pedestrian Dead Reckoning (PDR), inertial navigational systems, magnetic positioning systems, and the like. In some embodiments, the location detection system 202 uses existing wireless technologies to perform geo-positioning, which may include Wi-Fi-based positioning systems (WPS), Bluetooth-based positioning systems, Radio-Frequency Identification (RFID) systems, and others. In other embodiments, the location detection system may include video processing systems, ultrasound-based systems, visible light communication systems, and so forth.

[0044] The location detection system 202 can allow geo-fences to be drawn on a map and notify the enterprise server 203 when a medical device crosses the geo-fences (e.g., when the medical device enters a geo-fenced area, exits a geo-fenced area, or both). If a hospital administrator wishes to take certain actions (e.g., track the locations of medical devices, reconfigure the settings on medical devices, etc.) in response to medical devices entering or exiting specific areas of the hospital (e.g., rooms, floors, wings, buildings, or clinical care areas such as emergency room, operating room, intensive care unit, etc.), he or she may configure the location detection system 202 to monitor movements of medical devices across the boundaries of such areas. In response to the notification from the location detection system 202 that a medical device has entered a designated geo-fenced area, the enterprise server 203 may transmit further instructions, for example, to the hospital server in communication with the medical device. In some embodiments, the medical device determines its own location (e.g., using a tag or a tracking device built into the medical device) and communicates its location or any other associated information (e.g., an identifier associated with the geo-fenced area in which the medical device is located) to one or more of the location detection system 202, the

enterprise server 203, or the hospital server. In some embodiments, one or more of the location detection system 202, the enterprise server 203, or the hospital server determine, estimate, or derive the location of the medical device from the IP address of the medical device (e.g., using netmask and/or a map of access points within the hospital facility). In such embodiments, the location of the medical device can be determined, estimated, or derived using existing hardware (e.g., for implementing IEEE 802.X protocols) and maps (e.g., map of access points established on the hospital server), and the expense and complexity associated with implementing a traditional location system can be avoided or reduced.

[0045] In some embodiments, the location detection system 202 also detects how the medical devices entered or exited a geo-fenced area, and different actions may be triggered depending on the manner in which the medical device has entered or exited the geo-fenced area. For example, the enterprise server or the hospital server may take one action if an infusion pump exited the hospital through the front door and another action if the infusion pump exited on an ambulance.

Dwell Time in Location Detection

[0046] In some embodiments, the location detection system 202 does not send a location change notification to the enterprise server 203 (or a hospital server) unless the location change holds at least a threshold amount of time. For example, an infusion pump may be traveling from geo-fenced area A, through geo-fenced area B, to geo-fenced area C (which may correspond to three different rooms, floors, clinical care areas, wings, buildings, etc.). The location detection system 202 may detect the location change from area A to area B, but based on the amount of time that the infusion pump spent in area B being less than 5 minutes, the location detection system may refrain from sending a notification to the enterprise server. Once the infusion pump arrives at area C, based on the amount of time that the infusion pump spent in area C being greater than or equal to 5 minutes, the location detection system may send a notification to the enterprise server that the location of the infusion pump has changed from area A to area C.

[0047] Additionally or alternatively, the location detection system 202 may not send a location change notification to the enterprise server 203 (or a hospital server) unless the medical device is stationary for at least a threshold amount of time. For example, an infusion pump may be traveling from geo-fenced area A, through geo-fenced area B, to geo-fenced area C (which may correspond to three different rooms, floors, clinical care areas, wings, buildings, etc.). The location detection system 202 may detect the location change from area A to area B,

but based on the fact that the infusion pump is continuously moving (or remaining stationary for less than the threshold amount of time) in area B, the location detection system may refrain from sending a notification to the enterprise server. Once the infusion pump arrives at area C, based on the infusion pump remaining stationary for at least the threshold amount of time in area C, the location detection system may send a notification to the enterprise server that the location of the infusion pump has changed from area A to area C.

Enterprise Server

[0048] The enterprise server 203 may be a server in charge of the entire hospital or enterprise that can communicate with all hospital servers in the hospital or enterprise (e.g., the hospital environment 200). The enterprise server 203 may send instructions to the location detection system 202 to identify the medical devices that the location detection system 202 should monitor and to define the gen-fencing boundaries that the enterprise server 203 should be notified about. In response to a notification from the location detection system 202 indicating that a monitored medical device has entered a new geo-fenced area, the enterprise server 203 may take certain designated actions such as log the location change of the medical device, instruct the hospital server connected to the medical device to update the settings on the medical device, and the like. In some embodiments, the enterprise server 203 is omitted, and the location detection system 202 communicates directly with one or more of the hospital servers in the hospital environment 200.

[0049] In some embodiments, the enterprise server 203 (or the hospital server if location change notification is sent directly to the hospital server) may determine whether the location detection system 202 is an authorized, authenticated service prior to initiating any location-based actions described herein. The enterprise server 203 may utilize OAuth or another authorization protocol such as a public/private key certificate exchange.

Network

[0050] The network 204 may be any wired network, wireless network, or combination thereof. In addition, the network 204 may be a personal area network, local area network, wide area network, over-the-air broadcast network (e.g., for radio or television), cable network, satellite network, cellular telephone network, or combination thereof. For example, the network 204 may be a publicly accessible network of linked networks such as the Internet. For example, the communications between the location detection system 202 and the enterprise server 203 may be over a publicly accessible network of linked networks such as the Internet,

and the communications between the enterprise server 203 and the hospital servers 206A and 206B (and also the communications between the hospital server 206A and the medical device 208A, and the communications between the hospital server 206B and the medical device 208B) may be implemented on one or more wired and/or wireless private networks. The enterprise server 203 may be a cloud server that includes a collection of services, which are delivered via the network 204 as web services.

Hospital Server

[0051] The hospital servers 206A and 206B may each represent a version of the MMU server 3108 described with reference to **FIG. 1**. For example, the hospital server 206A may communicate with the medical devices in Hospital A (e.g., update settings on medical devices, send commands to medical devices to initiate or stop clinical operations, and the like), and the hospital server 206B may communicate with the medical devices in Hospital B that is separate from Hospital A (but may belong to the same hospital network or enterprise as Hospital A).

Medical Device

[0052] The medical devices 208A and 208B may be any medical device that are mobile and can be moved across the geo-fences monitored by the location detection system 202. For example, the medical devices 208A and 208B can be infusion pumps, patient monitors, and the like. The medical devices 208A and 208B are described in greater detail below with reference to **FIG. 3**.

[0053] With reference to **FIG. 3**, the components of an example medical device are described in greater detail. The example architecture of the medical devices 208A and 208B depicted in **FIG. 2** includes an arrangement of computer hardware and software modules that may be used to implement aspects of the present disclosure. The medical device 304 may include many more (or fewer) elements and/or sub-elements than those shown in **FIG. 3**. It is not necessary, however, that all of these elements be shown in order to provide an enabling disclosure.

[0054] As illustrated, the medical device 304 includes a display 306, a processor 308, a network interface 310, and a memory 312, all of which may communicate with one another by way of a communication bus. The display 306 may display information generated or stored by the medical device 304 or any other information associated with the medical device 304. For example, the medical device may be an infusion pump being used to

deliver medication to a patient. In such a case, the display 306 may display the volume of the medication infused so far, the volume of the medication to be infused, the rate at which the medication is being infused, and the like. The processor 308 may receive information and instructions from other computing systems or services via a network. The processor 308 may also transmit information to and receive information from the memory 312 and further provide content to the display 306 for display. The network interface 310 may provide connectivity to one or more networks or computing systems in the network environment described herein. For example, the network interface 310 may be a serial port, a parallel port, or any other communication interface that can enable or facilitate wired or wireless communication according to any communication protocols such as Zigbee (e.g., IEEE 802.15.4), Bluetooth, Wi-Fi (e.g., IEEE 802.11), Near Field Communication (NFC), and the like.

[0055] The memory 312 may contain computer program instructions (grouped as modules in some embodiments) that the processor 308 can execute in order to implement one or more aspects of the present disclosure. The memory 312 may include RAM, ROM, and/or other persistent, auxiliary, or non-transitory computer-readable media. In some embodiments, the memory 312 stores an operating system that provides computer program instructions for use by the processor 308 in the general administration and operation of the medical device 304. As illustrated in **FIG. 3**, the memory 312 may include network data 314, server data 316, and operational data 318. In some embodiments, the medical device 304 uses the network data 314 to connect to a network in the hospital environment (e.g., Wi-Fi network), uses the server data 316 to connect to a hospital server in the hospital environment (e.g., MMU server 3108 of **FIG. 1**), and uses the operational data 318 to perform one or more clinical operations (e.g., initiate an infusion therapy on a patient). In some embodiments, the operational data may also referred to herein as clinical data or clinical settings.

[0056] Although not shown in **FIG. 3**, the memory 312 may store programs, instructions, modules, libraries, settings, parameters, and/or other types of data that may be used by the medical device 304 to perform its operations. For example, the memory 312 may store location data indicating the current location of the medical device 304. Such location data may be updated in response to the change in the location of the medical device 304, and transmitted to the hospital server and/or the enterprise server for monitoring and logging purposes (e.g., such that various location-based metrics such as device utilization can be generated based on how long the individual medical devices spend in which geographical areas such as hospital rooms, cleaning stations, specific clinical care areas, specific buildings and facilities, etc.).

[0057] As another example, the memory 312 may store network profiles for multiple networks that may be used by the medical device 304 to connect to any of such networks. Additionally or alternatively, the memory 312 may store server profiles for multiple hospital servers that may be used by the medical device 304 to connect to any of such hospital servers. In such cases, the enterprise server and/or the hospital server described herein may first determine whether the medical device 304 already stores the network profile and/or the server profile associated with the newly-entered geographical area prior to providing such information to the medical device 304. Based on the medical device 304 already storing such information, the enterprise server and/or the hospital server may refrain from sending such information to the medical device 304. Based on the medical device 304 not already storing any portion of such information, the enterprise server and/or the hospital server may send such portion of the information to the medical device 304. In other embodiments, the medical device 304 may be configured to only one network profile and/or only one server profile at a time, and the enterprise server and/or the hospital server may provide the network/server information associated with the newly-entered geographical without such determination.

[0058] Although the present disclosure describes reconfiguring the settings on medical devices, the embodiments described herein are not limited as such, and the techniques described herein can be applied to any type of data (e.g., programs, instructions, modules, libraries, settings, parameters, and/or other types of data) that is location-specific and may need to be updated in response to the location of the medical devices being changed.

[0059] Although not shown in **FIG. 3**, the medical device 304 may further include one or more input devices such as a touch screen, mechanical buttons, or a voice recognition system. Also, the medical device 304 may include any other number of components such as multiple displays, multiple processors, multiple network interfaces, and/or multiple memories. Further, the medical device 304 may include one or more additional storage devices for storing data generated by the medical device 304 or other data utilized in implementing aspects of the present disclosure.

Movement of Medical Device Across Geographical Areas

[0060] With reference now to **FIG. 4**, an example hospital environment 400 will be described. The hospital environment 400 includes a geographical area 400A (e.g., geo-fence A) including a server 402A and a geographical area 400B (e.g., geo-fence B) including a server 402B. Although the servers 402A and 402B are illustrated as being located within the

geographical areas 400A and 400B, respectively, in some embodiments, one or both of the servers 402A and 402B are located outside the corresponding illustrated geographical area.

[0061] As shown in **FIG. 4**, a medical device 404 including network data 406A, server data 408A, and operational data 410A was previously in the geographical area 400A and connected to the server 402A. The medical device 404 is then moved to the geographical area 400B. In response to detecting that the medical device 404 has entered the geographical area 400B, a location detection system (e.g., location detection system 202 of **FIG. 2**) may transmit a notification to an enterprise server (e.g., enterprise server 203 of FIG. 2) or the server 402A, indicating that the medical device 404 has entered the geographical area 400B, which is associated with a different server, server 402B. In response to the notification, the server 402A may provide updated network data 406B and server data 408B to the medical device 404 (e.g., over an existing wireless network connection established between the server 402A and the medical device 404). The medical device 404 may connect to the wireless network available in the geographical area 400B using the received updated network data 406B, and connect to the server 402B using the received updated server data 408B. In response to determining that the medical device 404 has operational data 410B that is incompatible with the geographical area 400B, the server 402B may transmit updated operational data 410B to the medical device 404. While the medical device is located in the geographical area 400B, the medical device 404 may perform clinical operations using the updated operational data 410B. The medical device reconfiguration process is described in greater detail below with reference to **FIG. 5**.

[0062] Although all of the network data, server data, and operational data are updated in the example of **FIG. 4**, in some embodiments, only one or some of the data stored on the medical device 404 may be updated in response to a location change of the medical device. For example, if the medical device 404 is moved to a different geo-fenced area that is managed by the same hospital server to which the medical device 404 is already connected, the server data may not need to be updated since the medical device 404 can continue to communicate with the same hospital server in the new geo-fenced area. As another example, if the medical device 404 is moved to a different geo-fenced area that is still part of the same wireless network to which the medical device 404 is already connected, the network data may not need to be updated since the medical device 404 can continue to access the same wireless network in the new geo-fenced area. As another example, if the medical device 404 is moved to a different geo-fenced area that uses the same operational data (e.g., drug library version, safety parameters, etc.) as the geo-fenced area in which the medical device 404 was previously located, the operational data may not need to be updated since the medical device 404 can

continue to use the same operational data to perform its clinical operations in the new geo-fenced area.

Medical Device Reconfiguration Process

[0063] With reference now to **FIG. 5**, an example medical device reconfiguration process 500 will be described. At step 502, pump X connects to hospital server A. When the infusion pump connects to the hospital server for the first time, the hospital server may check the settings on the infusion pump (e.g., network settings, server settings, safety settings, drug library versions, etc.) and cause some or all of the settings on the infusion pump to be updated as needed (e.g., by transmitting updated settings to the infusion pump). The same process of ensuring that the medical device has the latest settings and versions may be repeated the next time the infusion pump connects to the hospital server. In some embodiments, after the first time, the hospital server may omit one or more of the steps performed to ensure that the medical device has the latest settings and versions (e.g., based on how long ago the medical device last connected to the hospital server).

[0064] At step 504, pump X is moved from hospital A (managed by hospital server A) to hospital B (managed by hospital server B). For example, the infusion pump connected to a patient admitted at hospital A may have been transported to hospital B along with the patient.

[0065] At step 506, the real-time location system (RTLS) detects that pump X has moved into geo-fence B that has been defined at hospital B. For example, as pump X is moved into geo-fence B, a detector or receiver located at hospital B may detect the presence of pump X within the geo-fence B. As discussed with reference to **FIG. 2**, the RTLS may utilize any of a variety of location detection technologies to detect the location change of pump X. As part of the detection process, the RTLS may determine an identifier associated with pump X (e.g., ID of a location detection tag attached to pump X, or ID of pump X).

[0066] At step 508, the RTLS transmits a notification to the enterprise server, indicating that pump X has moved into geo-fence B. The notification may include the identifier associated with pump X determined at step 506 and an identifier associated with geo-fence B.

[0067] At step 510, the enterprise server determines that pump X is connected to hospital server A and geo-fence B corresponds to hospital server B. For example, the enterprise server determines the identity of pump X using the identifier associated with pump X included in the notification, and determines the identity of hospital server B using the identifier associated with geo-fence B included in the notification. The enterprise server may maintain and/or access a database table associating the location detection tags with the respective pumps,

and determine the identity of pump X using the database table. Similarly, the enterprise server may maintain and/or access a database table associating the geo-fenced areas monitored by the RTLS with the respective hospital servers, and determine the identity of hospital server B using the database table.

[0068] At step 512, the enterprise server instructs hospital server A to cause pump X to connect to hospital server B. In some embodiments, only the hospital server (and not other hospital servers) connected to the infusion pump may be able to communicate with and send instructions to the infusion pump. The enterprise server may provide to hospital server A certain information that pump X would need in order to connect to hospital server B, such as network settings (e.g., SSID and pre-shared key) to connect to the Wi-Fi network at hospital B, server settings (e.g., the IP address of hospital server B) to connect to hospital server B over the network at hospital B, and other information such as a security certificate to communicate with the hospital server B over the network at hospital B.

[0069] At step 514, hospital server A instructs pump X to connect to hospital server B. For example, hospital server A may identify pump X using the identifier received from the enterprise server, and send a command to pump X including the information provided by the enterprise server (e.g., network settings, server settings, etc.). In some embodiments, the enterprise server provides the identifier of pump X and the identifier of hospital server B, and hospital server A determines the network settings, server settings, and other information that pump X would need in order to connect to hospital server B based on the identifiers provided by the enterprise server. Hospital server A then transmits such information to pump X.

[0070] At step 516, pump X connects to hospital server B. For example, in response to the communication from hospital server A, pump X connects to the Wi-Fi network at hospital B, and then connects to hospital server B over the Wi-Fi network using the IP address received from hospital server A.

[0071] At step 518, hospital server B detects that pump X has connected and determines that pump X needs updated operational settings (e.g., drug library, safety parameters, etc.). For example, hospital B may have stricter safety protocols and have tighter drug library limits for performing infusion therapies.

[0072] At step 520, hospital server B transmits updated settings to pump X, and at step 522, the settings on pump X are updated based on the updated settings received from hospital server B.

[0073] In the process 500, one or more of the steps shown in **FIG. 5** may be removed (e.g., not performed) and/or the order in which the method 500 is performed may be

switched. In some embodiments, additional steps may be added to the process 500. Although the process 500 is described in the context of updating the settings on an infusion pump, the techniques described herein can be extended to updating other types of data on other types of medical devices. The embodiments of the present disclosure are not limited to or by the example shown in **FIG. 5**, and other variations may be implemented without departing from the spirit of this disclosure.

Example Multi-Server Medical Device Reconfiguration Method

[0074] With reference now to **FIG. 6**, an example multi-server medical device reconfiguration method 600 will be described. The example method 600 may be carried out, for example, by the MMU server 3108 of **FIG. 1**, the hospital server 206A of **FIG. 2**, or the server 402A of **FIG. 4** (or one or more components thereof). For convenience, the steps of the example method 600 are described as being performed by a server. The method 600 illustrates an example algorithm that may be programmed, using any suitable programming environment or language, to create machine code capable of execution by a CPU or microcontroller of the server. Various embodiments may be coded using assembly, C, OBJECTIVE-C, C++, JAVA, or other human-readable languages and then compiled, assembled, or otherwise transformed into machine code that can be loaded into read-only memory (ROM), erasable programmable read-only memory (EPROM), or other recordable memory of the server that is coupled to the CPU or microcontroller and then then executed by the CPU or microcontroller.

[0075] At block 602, the server receives a request to connect from a medical device. The medical device may be an infusion pump connecting to the server at the hospital in which the infusion pump is located.

[0076] At block 604, the server transmits a first set of clinical settings to the medical device. For example, in response to detecting that the medical device has connected and determining that the medical device needs an updated drug library or updated safety parameters, the server can transmit such information to the medical device.

[0077] At block 606, the server determines that the medical device has performed a clinical operation using at least part of the clinical settings. For example, using the updated drug library or updated safety settings, the medical device may perform an infusion therapy on patient (e.g., in response to a command received from the server) and report to the server that the infusion therapy has been initiated (or completed). In some cases, the infusion therapy may be defined by certain parameters that may not have been allowed under the safety settings stored on the medical device prior to block 604.

[0078] At block 608, the server determines that the medical device has entered another geographical region associated with a remote server. For example, the server can make such a determination based on a notification received from the location detection system 202 (e.g., directly from the location detection system 202 or indirectly via the enterprise server 203).

[0079] At block 610, the server transmits, to the medical device, one or more settings usable by the medical device to connect to the remote server. For example, such settings may include network settings (e.g., SSID and pre-shared key) to connect to the Wi-Fi network in the new geographical region, server settings (e.g., the IP address) to connect to the remote server over the network at the new geographical region, and/or other information such as a security certificate to communicate with the remote server over the network at the new geographical region. Although not shown in **FIG. 6**, the server may terminate the network connection to the medical device in response to the medical device establishing a network connection to the remote server (or sometime thereafter).

[0080] In the method 600, one or more of the blocks shown in **FIG. 6** may be removed (e.g., not performed) and/or the order in which the method 600 is performed may be switched. In some embodiments, additional blocks may be added to the method 600. The embodiments of the present disclosure are not limited to or by the example shown in **FIG. 6**, and other variations may be implemented without departing from the spirit of this disclosure.

Example Single-Server Medical Device Reconfiguration Method

[0081] With reference now to **FIG. 7**, an example single-server medical device reconfiguration method 700 will be described. The example method 700 may be carried out, for example, by the MMU server 3108 of **FIG. 1** , the hospital server 206A of **FIG. 2**, or the server 402A of **FIG. 4** (or one or more components thereof). For convenience, the steps of the example method 700 are described as being performed by a server. The method 700 illustrates an example algorithm that may be programmed, using any suitable programming environment or language, to create machine code capable of execution by a CPU or microcontroller of the server. Various embodiments may be coded using assembly, C, OBJECTIVE-C, C++, JAVA, or other human-readable languages and then compiled, assembled, or otherwise transformed into machine code that can be loaded into read-only memory (ROM), erasable programmable read-only memory (EPROM), or other recordable memory of the server that is coupled to the CPU or microcontroller and then then executed by the CPU or microcontroller.

[0082] At block 702, the server receives an indication from a location detection system that a medical device has entered a geographical area. For example, the server can make

such a determination based on a notification received from the location detection system 202 (e.g., directly from the location detection system 202 or indirectly via the enterprise server 203). The geographical area may be a different clinical care area that is still managed by the same server and may include updated safety settings that are specific to the that clinical care area.

[0083] At block 704, the server determines that the location detection system is authorized. For example, the server (e.g., the enterprise server or the hospital server) may determine whether the location detection system is an authorized, authenticated service prior to initiating any location-based actions described herein. The server may utilize OAuth or another authorization protocol such as a public/private key certificate exchange.

[0084] At block 706, the server transmits an instruction to the medical device to update one or more of the settings stored on the medical device. In some embodiments, the settings are updated in response to the instruction transmitted from the server without further user approval. In other embodiments, the settings are updated only after a human operator (e.g., the clinician operating the medical device) approves the update via the user interface provided by the medical device (e.g., by hitting the confirm key after viewing the proposed update displayed on the display of the medical device).

[0085] At block 708, the server determines that the medical device has performed a clinical operation based on at least part of the update settings. For example, using the updated drug library or updated safety settings specific to the new geographical area (e.g., new clinical care area), the medical device may perform an infusion therapy on patient (e.g., in response to a command received from the server) and report to the server that the infusion therapy has been initiated (or completed). In some cases, the infusion therapy may be defined by certain parameters that may not have been allowed under the old settings previously stored on the medical device prior to block 706.

[0086] In the method 700, one or more of the blocks shown in **FIG. 7** may be removed (e.g., not performed) and/or the order in which the method 700 is performed may be switched. In some embodiments, additional blocks may be added to the method 700. The embodiments of the present disclosure are not limited to or by the example shown in **FIG. 7**, and other variations may be implemented without departing from the spirit of this disclosure.

Example Embodiments

[0087] In one embodiment, a system configured to update medical device settings includes: a location detection system configured to monitor location information associated with a plurality of medical devices; a first server configured to update configuration

information stored on one or more medical devices in a first geographical region; and a second server configured to update configuration information stored on one or more medical devices in a second geographical region different from the first geographical region, wherein the location detection system is further configured to: determine that a first medical device has entered the second geographical region, the first medical device including a first set of network settings usable to communicate with the first server and a first set of clinical settings usable to perform clinical operations in the first geographical region; and transmit an indication to the first server that the first medical device has entered the second geographical region, wherein the first server is further configured to: in response to the indication that the first medical device has entered the second geographical region, transmit, to the first medical device, a second set of network settings usable to communicate with the second server, and wherein the second server is further configured to: in response to a connection request from the first medical device, determine that the first set of clinical settings stored on the first medical device need to be updated; and transmit, to the first medical device, a second set of clinical settings usable to perform clinical operations in the second geographical region.

[0088] In one embodiment, the second server is further configured to transmit an instruction to the first medical device to initiate an infusion therapy to a patient in the second geographical region using the second set of clinical settings. In one embodiment, the first server is further configured to, in response to a connection request from the first medical device, determine that the second set of clinical settings stored on the first medical device need to be updated, and transmit, to the first medical device, the first set of clinical settings previously stored on the first medical device. In one embodiment, the first server is further configured to transmit, along with the second set of network settings, a Wi-Fi setting usable by the first medical device to connect to a Wi-Fi network associated with the second server.

[0089] In one embodiment, a server configured to update configuration information stored on one or more medical devices in a first geographical region, is further configured to: receive a request to connect to the server from a medical device configured to perform clinical operations; transmit, to the medical device, a first set of clinical settings usable to perform the clinical operations in the first geographical region; determine that the medical device has performed a clinical operation in the first geographical area using at least part of the first set of clinical settings; determine that the medical device has entered a second geographical area associated with a remote server configured to update configuration information stored on one or more medical devices in the second geographical region, wherein the second geographical

area is different from the first geographical area; and transmit one or more settings to the medical device that are usable by the medical device to connect to the remote server.

[0090] In one embodiment, the server is further configured to, prior to transmitting the first set of settings to the medical device, determine that the medical device does not have at least some of the first set of settings usable to perform the clinical operations in the first geographical region. In one embodiment, the server is further configured to transmit an instruction to initiate an infusion therapy to a patient in the first geographical area. In one embodiment, the server is further configured to, subsequent to transmitting the one or more settings to the medical device, determine that the medical device is no longer connected to the server. In one embodiment, the server is further configured to determine that the medical device has entered the second geographical area associated with the remote server based on a notification generated by a location detection system configured to detect that the medical device has entered the second geographical area. In one embodiment, the server is further configured to, subsequent to transmitting the one or more settings to the medical device, receive another request to connect to the server from the medical device, and transmit the first set of clinical settings to the medical device based on a determination that the medical device does not have the first set of clinical settings.

[0091] In one embodiment, the server is further configured to, subsequent to transmitting the one or more settings to the medical device, receive another request to connect to the server from the medical device, and refrain from transmitting the first set of clinical settings to the medical device based on a determination that the medical device already has the first set of clinical settings. In one embodiment, the one or more settings transmitted to the medical device comprise a Wi-Fi setting usable by the medical device to connect to a Wi-Fi network associated with the remote server.

[0092] In one embodiment, a method of updating configuration information stored on one or more medical devices in a first geographical region comprises: receiving a request to connect to the server from a medical device configured to perform clinical operations; transmitting, to the medical device, a first set of clinical settings usable to perform the clinical operations in the first geographical region; receiving an indication that the medical device has performed a clinical operation in the first geographical area using at least part of the first set of clinical settings; receiving an indication that the medical device has entered a second geographical area associated with a remote server configured to update configuration information stored on one or more medical devices in the second geographical region, wherein the second geographical area is different from the first geographical area; and transmitting one

or more settings to the medical device that are usable by the medical device to connect to the remote server.

[0093] In one embodiment, the method further comprises, prior to transmitting the first set of settings to the medical device, determining that the medical device does not have at least some of the first set of settings usable to perform the clinical operations in the first geographical region. In one embodiment, the method further comprises, transmitting an instruction to initiate an infusion therapy to a patient in the first geographical area. In one embodiment, the method further comprises, subsequent to transmitting the one or more settings to the medical device, determining that the medical device is no longer connected to the server.

[0094] In one embodiment, the method further comprises, determining that the medical device has entered the second geographical area associated with the remote server based on a notification generated by a location detection system configured to detect that the medical device has entered the second geographical area. In one embodiment, the method further comprises, subsequent to transmitting the one or more settings to the medical device, receiving another request to connect to the server from the medical device, and transmitting the first set of clinical settings to the medical device based on a determination that the medical device does not have the first set of clinical settings. In one embodiment, the method further comprises, subsequent to transmitting the one or more settings to the medical device, receive another request to connect to the server from the medical device, and refraining from transmitting the first set of clinical settings to the medical device based on a determination that the medical device already has the first set of clinical settings. In one embodiment, the one or more settings transmitted to the medical device comprise a Wi-Fi setting usable by the medical device to connect to a Wi-Fi network associated with the remote server.

Other Considerations

[0095] It is to be understood that not necessarily all objects or advantages may be achieved in accordance with any particular embodiment described herein. Thus, for example, those skilled in the art will recognize that certain embodiments may be configured to operate in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other objects or advantages as may be taught or suggested herein.

[0096] Many other variations than those described herein will be apparent from this disclosure. For example, depending on the embodiment, certain acts, events, or functions of any of the algorithms described herein can be performed in a different sequence, can be added, merged, or left out altogether (e.g., not all described acts or events are necessary for the practice

of the algorithms). Moreover, in certain embodiments, acts or events can be performed concurrently, e.g., through multi-threaded processing, interrupt processing, or multiple processors or processor cores or on other parallel architectures, rather than sequentially. In addition, different tasks or processes can be performed by different machines and/or computing systems that can function together.

[0097] The various illustrative logical blocks, modules, and algorithm elements described in connection with the embodiments disclosed herein can be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, and elements have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. The described functionality can be implemented in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the disclosure.

[0098] The various illustrative logical blocks and modules described in connection with the embodiments disclosed herein can be implemented or performed by a machine, such as a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor can be a microprocessor, but in the alternative, the processor can be a controller, microcontroller, or state machine, combinations of the same, or the like. A processor can include electrical circuitry configured to process computer-executable instructions. In another embodiment, a processor includes an FPGA or other programmable device that performs logic operations without processing computer-executable instructions. A processor can also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. Although described herein primarily with respect to digital technology, a processor may also include primarily analog components. For example, some or all of the signal processing algorithms described herein may be implemented in analog circuitry or mixed analog and digital circuitry. A computing environment can include any type of computer system, including, but not limited to, a computer system based on a microprocessor, a mainframe computer, a digital signal processor, a portable computing device, a device controller, or a computational engine within an appliance, to name a few.

[0099] The elements of a method, process, or algorithm described in connection with the embodiments disclosed herein can be embodied directly in hardware, in a software module stored in one or more memory devices and executed by one or more processors, or in a combination of the two. A software module can reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, hard disk, a removable disk, a CD-ROM, or any other form of non-transitory computer-readable storage medium, media, or physical computer storage known in the art. An example storage medium can be coupled to the processor such that the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium can be integral to the processor. The storage medium can be volatile or nonvolatile. The processor and the storage medium can reside in an ASIC. The ASIC can reside in a user terminal. In the alternative, the processor and the storage medium can reside as discrete components in a user terminal.

[0100] Conditional language used herein, such as, among others, "can," "might," "may," "e.g.," and the like, unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments include, while other embodiments do not include, certain features, elements, and/or states. Thus, such conditional language is not generally intended to imply that features, elements and/or states are in any way required for one or more embodiments or that one or more embodiments necessarily include logic for deciding, with or without author input or prompting, whether these features, elements and/or states are included or are to be performed in any particular embodiment. The terms "comprising," "including," "having," and the like are synonymous and are used inclusively, in an open-ended fashion, and do not exclude additional elements, features, acts, operations, and so forth. Also, the term "or" is used in its inclusive sense (and not in its exclusive sense) so that when used, for example, to connect a list of elements, the term "or" means one, some, or all of the elements in the list. Further, the term "each," as used herein, in addition to having its ordinary meaning, can mean any subset of a set of elements to which the term "each" is applied.

[0101] Disjunctive language such as the phrase "at least one of X, Y, or Z," unless specifically stated otherwise, is otherwise understood with the context as used in general to present that an item, term, etc., may be either X, Y, or Z, or any combination thereof (e.g., X, Y, and/or Z). Thus, such disjunctive language is not generally intended to, and should not, imply that certain embodiments require at least one of X, at least one of Y, or at least one of Z to each be present.

[0102] Unless otherwise explicitly stated, articles such as "a", "an", or "the" should generally be interpreted to include one or more described items. Accordingly, phrases such as "a device configured to" are intended to include one or more recited devices. Such one or more recited devices can also be collectively configured to carry out the stated recitations. For example, "a processor configured to carry out recitations A, B, and C" can include a first processor configured to carry out recitation A working in conjunction with a second processor configured to carry out recitations B and C.

[0103] While the above detailed description has shown, described, and pointed out novel features as applied to various embodiments, it will be understood that various omissions, substitutions, and changes in the form and details of the devices or algorithms illustrated can be made without departing from the spirit of the disclosure. As will be recognized, certain embodiments described herein can be implemented within a form that does not provide all of the features and benefits set forth herein, as some features can be used or practiced separately from others. All such modifications and variations are intended to be included herein within the scope of this disclosure. Further, additional embodiments created by combining any two or more features or techniques of one or more embodiments described herein are also intended to be included herein within the scope of this disclosure.

WHAT IS CLAIMED IS:

1. A system configured to update medical device settings, the system comprising:

a location detection system configured to monitor location information associated with a plurality of medical devices;

a first server configured to update configuration information stored on one or more medical devices in a first geographical region; and

a second server configured to update configuration information stored on one or more medical devices in a second geographical region different from the first geographical region,

wherein the location detection system is further configured to:

determine that a first medical device has entered the second geographical region, the first medical device including a first set of network settings usable to communicate with the first server and a first set of clinical settings usable to perform clinical operations in the first geographical region; and

transmit an indication to the first server that the first medical device has entered the second geographical region,

wherein the first server is further configured to:

in response to the indication that the first medical device has entered the second geographical region, transmit, to the first medical device, a second set of network settings usable to communicate with the second server, and

wherein the second server is further configured to:

in response to a connection request from the first medical device, determine that the first set of clinical settings stored on the first medical device need to be updated; and

transmit, to the first medical device, a second set of clinical settings usable to perform clinical operations in the second geographical region.

2. The system of claim 1, wherein the second server is further configured to transmit an instruction to the first medical device to initiate an infusion therapy to a patient in the second geographical region using the second set of clinical settings.

3. The system of claim 1, wherein the first server is further configured to, in response to a connection request from the first medical device, determine that the second set of clinical settings stored on the first medical device need to be updated, and transmit, to the first medical device, the first set of clinical settings previously stored on the first medical device.

4. The system of claim 1, wherein the first server is further configured to transmit, along with the second set of network settings, a Wi-Fi setting usable by the first medical device to connect to a Wi-Fi network associated with the second server.

5. A server configured to update configuration information stored on one or more medical devices in a first geographical region, the server configured to:

receive a request to connect to the server from a medical device configured to perform clinical operations;

transmit, to the medical device, a first set of clinical settings usable to perform the clinical operations in the first geographical region;

determine that the medical device has performed a clinical operation in the first geographical area using at least part of the first set of clinical settings;

determine that the medical device has entered a second geographical area associated with a remote server configured to update configuration information stored on one or more medical devices in the second geographical region, wherein the second geographical area is different from the first geographical area; and

transmit one or more settings to the medical device that are usable by the medical device to connect to the remote server.

6. The server of claim 5, wherein the server is further configured to, prior to transmitting the first set of settings to the medical device, determine that the medical device does not have at least some of the first set of settings usable to perform the clinical operations in the first geographical region.

7. The server of claim 5, wherein the server is further configured to transmit an instruction to initiate an infusion therapy to a patient in the first geographical area.

8. The server of claim 5, wherein the server is further configured to, subsequent to transmitting the one or more settings to the medical device, determine that the medical device is no longer connected to the server.

9. The server of claim 5, wherein the server is further configured to determine that the medical device has entered the second geographical area associated with the remote server based on a notification generated by a location detection system configured to detect that the medical device has entered the second geographical area.

10. The server of claim 5, wherein the server is further configured to, subsequent to transmitting the one or more settings to the medical device, receive another request to connect to the server from the medical device, and transmit the first set of clinical settings to the medical device based on a determination that the medical device does not have the first set of clinical settings.

11. The server of claim 5, wherein the server is further configured to, subsequent to transmitting the one or more settings to the medical device, receive another request to connect to the server from the medical device, and refrain from transmitting the first set of clinical settings to the medical device based on a determination that the medical device already has the first set of clinical settings.

12. The server of claim 5, wherein the one or more settings transmitted to the medical device comprise a Wi-Fi setting usable by the medical device to connect to a Wi-Fi network associated with the remote server.

13. A method of updating configuration information stored on one or more medical devices in a first geographical region, the method comprising:

receiving a request to connect to the server from a medical device configured to perform clinical operations;

transmitting, to the medical device, a first set of clinical settings usable to perform the clinical operations in the first geographical region;

receiving an indication that the medical device has performed a clinical operation in the first geographical area using at least part of the first set of clinical settings;

receiving an indication that the medical device has entered a second geographical area associated with a remote server configured to update configuration information stored on one or more medical devices in the second geographical region, wherein the second geographical area is different from the first geographical area; and

transmitting one or more settings to the medical device that are usable by the medical device to connect to the remote server.

14. The method of claim 13, further comprising, prior to transmitting the first set of settings to the medical device, determining that the medical device does not have at least some

of the first set of settings usable to perform the clinical operations in the first geographical region.

15. The method of claim 13, further comprising transmitting an instruction to initiate an infusion therapy to a patient in the first geographical area.

16. The method of claim 13, further comprising, subsequent to transmitting the one or more settings to the medical device, determining that the medical device is no longer connected to the server.

17. The method of claim 13, further comprising determining that the medical device has entered the second geographical area associated with the remote server based on a notification generated by a location detection system configured to detect that the medical device has entered the second geographical area.

18. The method of claim 13, further comprising, subsequent to transmitting the one or more settings to the medical device, receiving another request to connect to the server from the medical device, and transmitting the first set of clinical settings to the medical device based on a determination that the medical device does not have the first set of clinical settings.

19. The method of claim 13, further comprising, subsequent to transmitting the one or more settings to the medical device, receive another request to connect to the server from the medical device, and refraining from transmitting the first set of clinical settings to the medical device based on a determination that the medical device already has the first set of clinical settings.

20. The method of claim 13, wherein the one or more settings transmitted to the medical device comprise a Wi-Fi setting usable by the medical device to connect to a Wi-Fi network associated with the remote server.

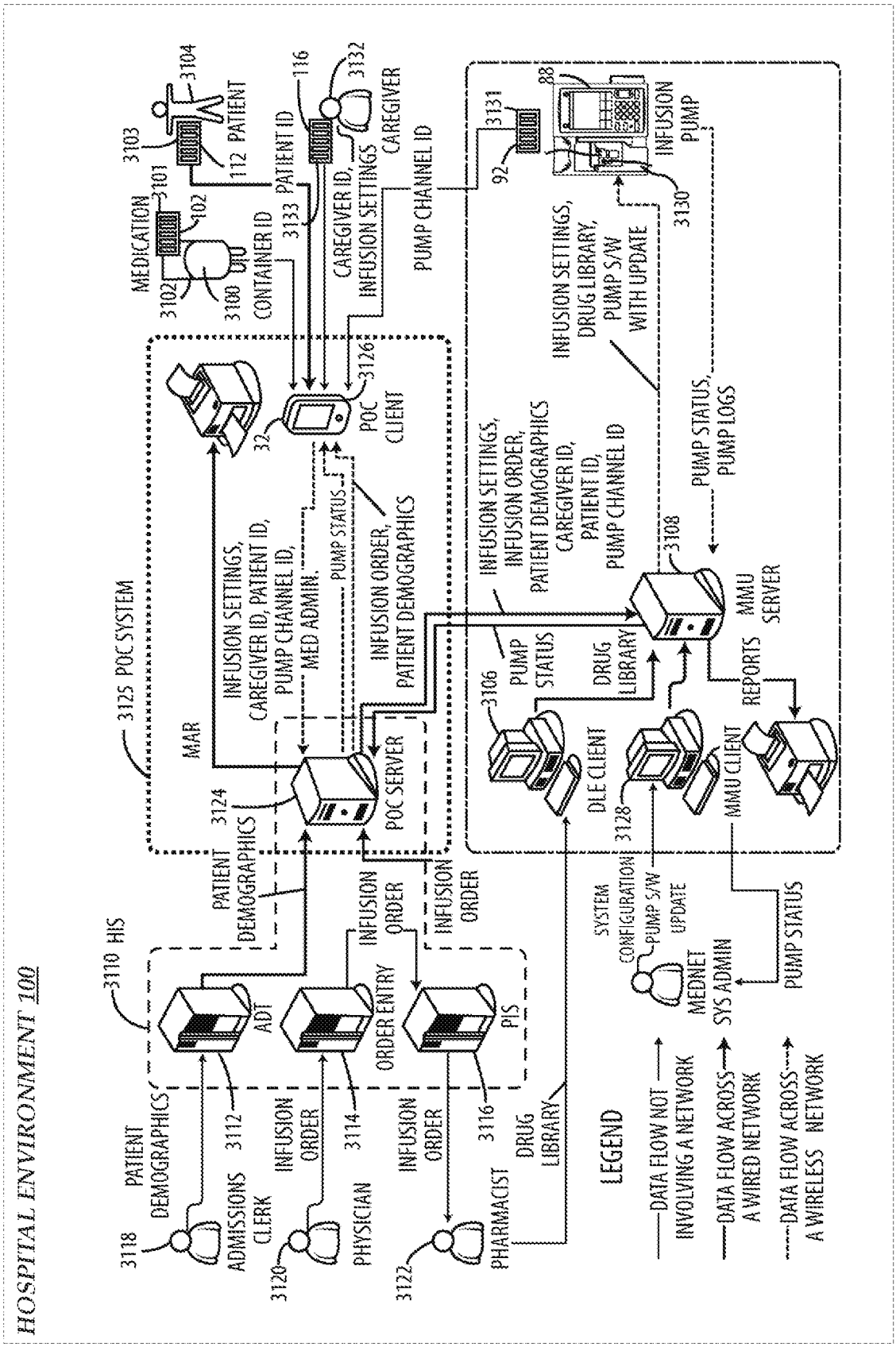
HOSPITAL ENVIRONMENT 100
3110 HIS
3125 POC SYSTEM
MAR
3124
POC SERVER
3126
POC CLIENT
32
3128
DLE CLIENT
3106
3108
MMU SERVER
MMU CLIENT
REPORTS
88
INFUSION PUMP
3130
92
3131
MEDICATION
3101
3102
3100
CONTAINER ID
3103
3104
112 PATIENT
PATIENT ID
3133
116
CAREGIVER ID,
INFUSION SETTINGS
3132
CAREGIVER
PUMP CHANNEL ID
INFUSION SETTINGS, CAREGIVER ID, PATIENT ID, PUMP CHANNEL ID, MED ADMIN.
PUMP STATUS
INFUSION ORDER, PATIENT DEMOGRAPHICS
INFUSION SETTINGS, INFUSION ORDER, PATIENT DEMOGRAPHICS CAREGIVER ID, PATIENT ID, PUMP CHANNEL ID
INFUSION SETTINGS, DRUG LIBRARY, PUMP S/W WITH UPDATE
PUMP STATUS, PUMP LOGS
PUMP STATUS
DRUG LIBRARY
REPORTS
PATIENT DEMOGRAPHICS
INFUSION ORDER
INFUSION ORDER
DRUG LIBRARY
3112
3114
3116
ADT
ORDER ENTRY
PIS
3118
ADMISSIONS CLERK
3120
PHYSICIAN
3122
PHARMACIST
SYSTEM CONFIGURATION
PUMP S/W UPDATE
MEDNET
SYS ADMIN
PUMP STATUS
LEGEND
DATA FLOW NOT INVOLVING A NETWORK
DATA FLOW ACROSS A WIRED NETWORK
DATA FLOW ACROSS A WIRELESS NETWORK

FIG. 1

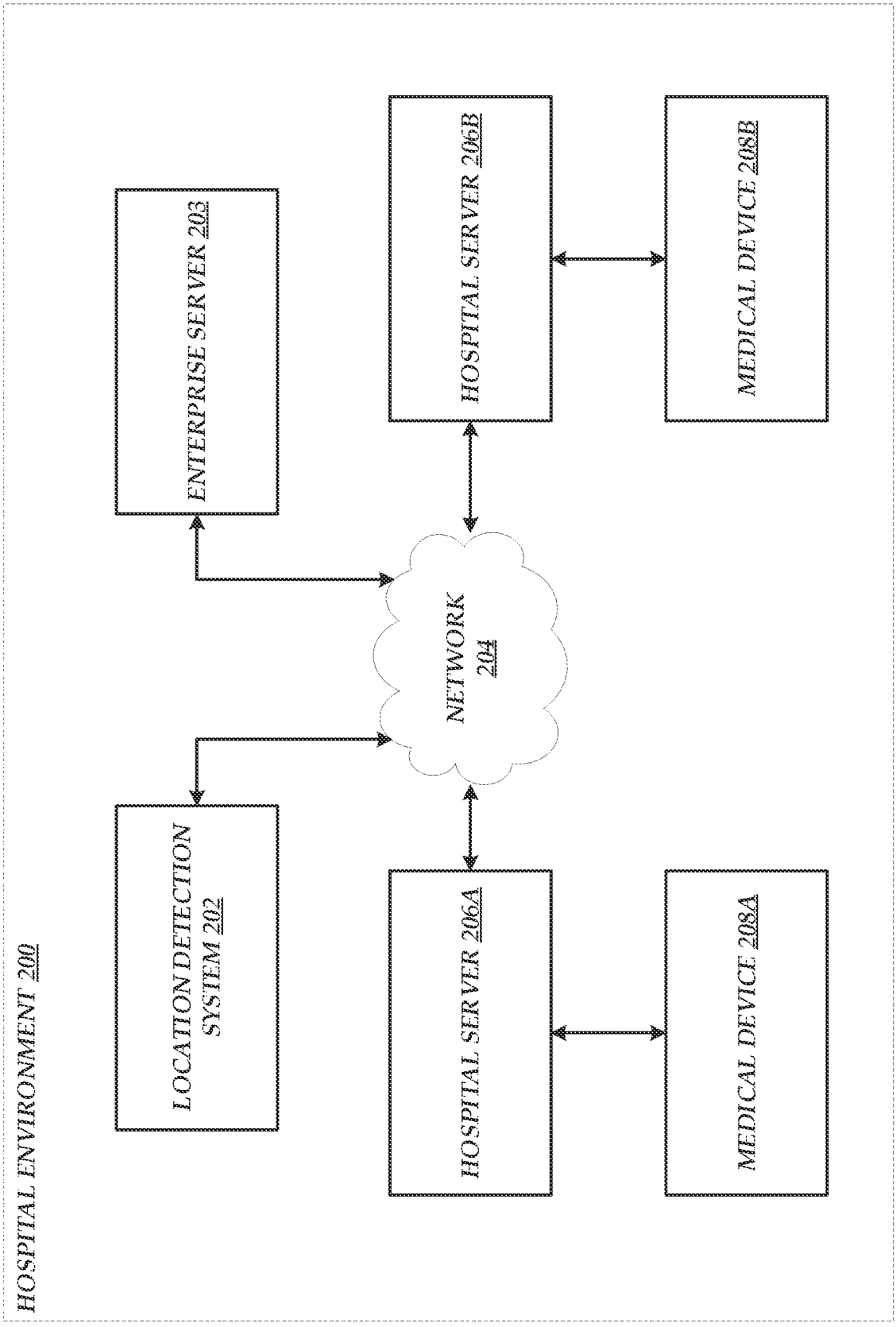
HOSPITAL ENVIRONMENT 200
LOCATION DETECTION SYSTEM 202
ENTERPRISE SERVER 203
NETWORK 204
HOSPITAL SERVER 206A
HOSPITAL SERVER 206B
MEDICAL DEVICE 208A
MEDICAL DEVICE 208B

FIG. 2

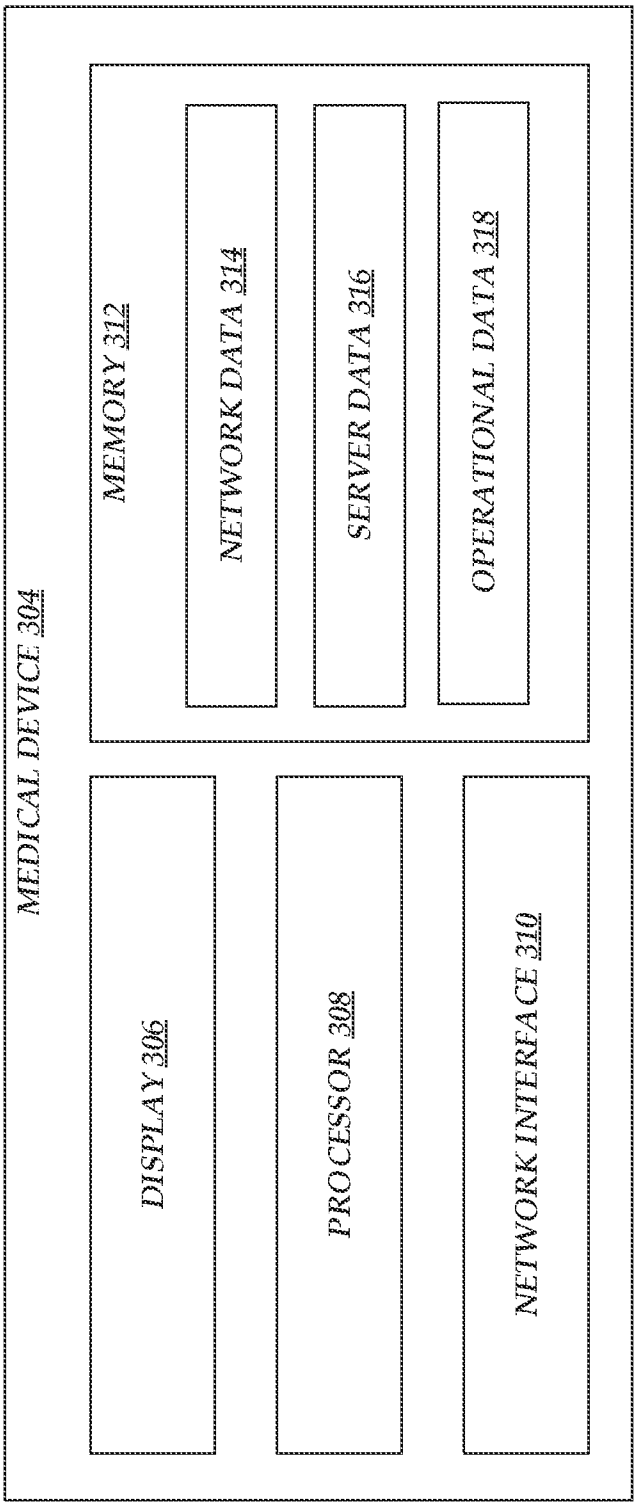
MEDICAL DEVICE 304
DISPLAY 306
PROCESSOR 308
NETWORK INTERFACE 310
MEMORY 312
NETWORK DATA 314
SERVER DATA 316
OPERATIONAL DATA 318

FIG. 3

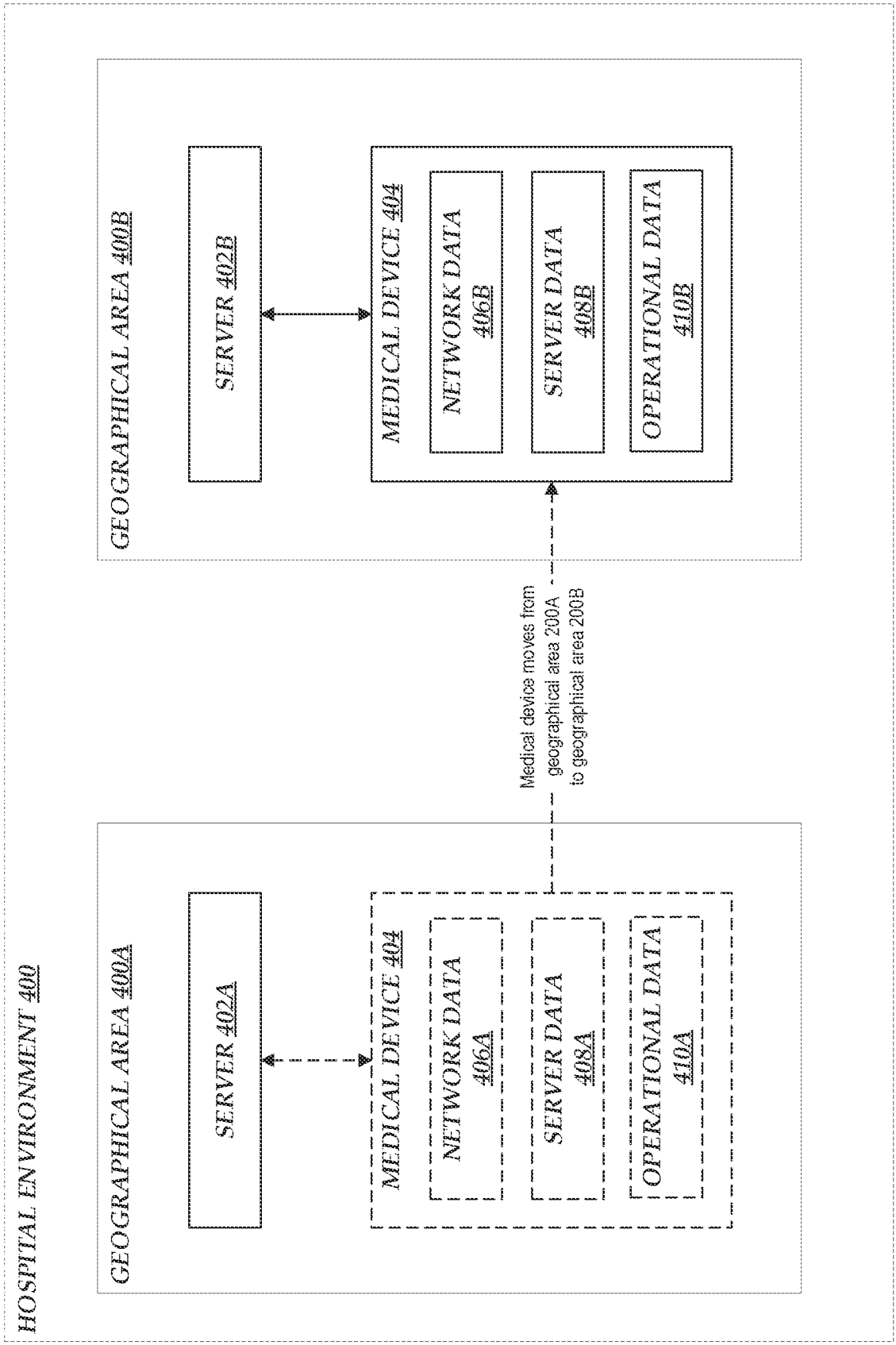
HOSPITAL ENVIRONMENT 400
GEOGRAPHICAL AREA 400A
SERVER 402A
MEDICAL DEVICE 404
NETWORK DATA 406A
SERVER DATA 408A
OPERATIONAL DATA 410A
Medical device moves from geographical area 200A to geographical area 200B
GEOGRAPHICAL AREA 400B
SERVER 402B
MEDICAL DEVICE 404
NETWORK DATA 406B
SERVER DATA 408B
OPERATIONAL DATA 410B

FIG. 4

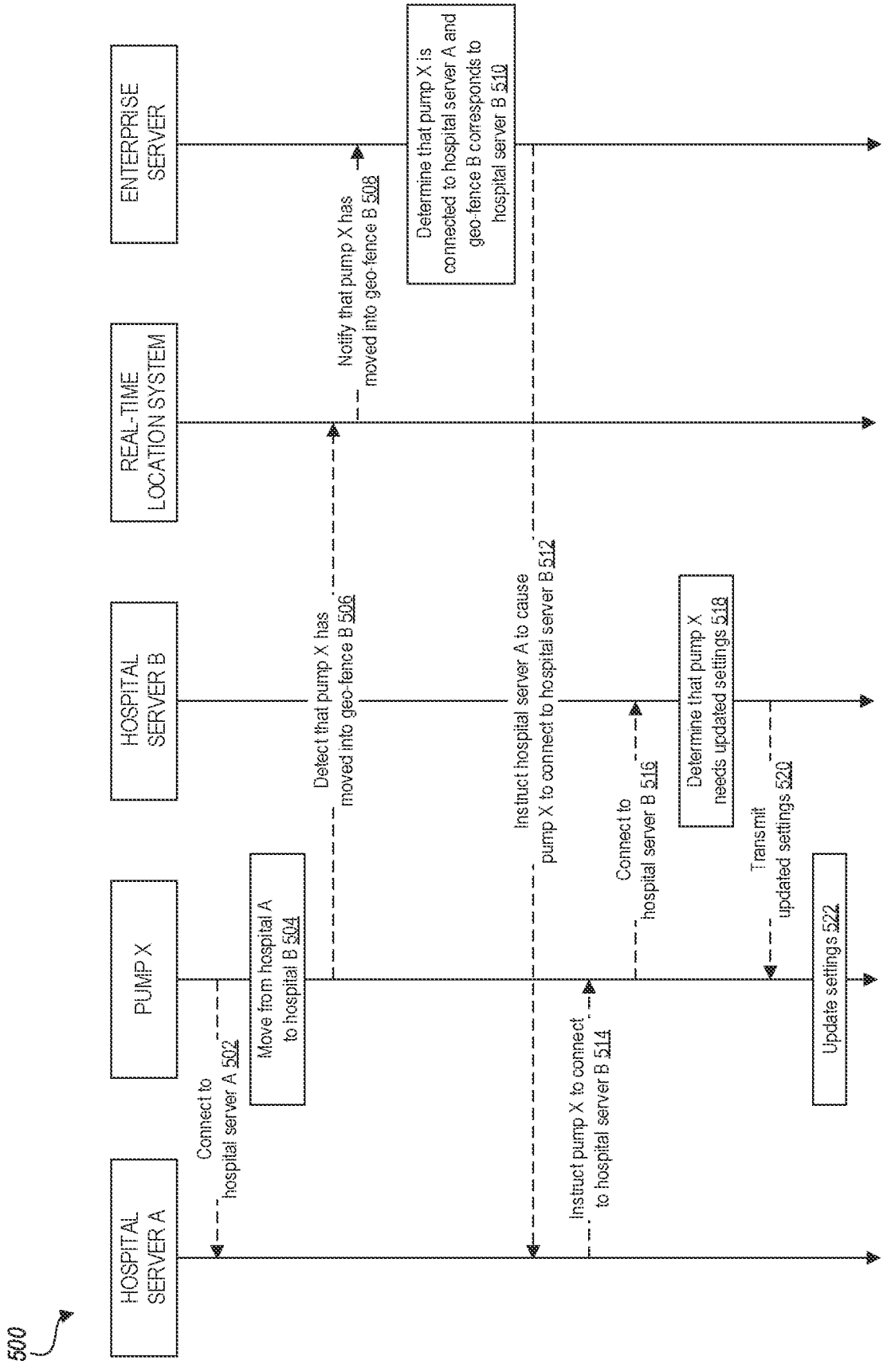
500
HOSPITAL SERVER A
PUMP X
HOSPITAL SERVER B
REAL-TIME LOCATION SYSTEM
ENTERPRISE SERVER
Connect to hospital server A 502
Move from hospital A to hospital B 504
Detect that pump X has moved into geo-fence B 506
Notify that pump X has moved into geo-fence B 508
Determine that pump X is connected to hospital server A and geo-fence B corresponds to hospital server B 510
Instruct hospital server A to cause pump X to connect to hospital server B 512
Instruct pump X to connect to hospital server B 514
Connect to hospital server B 516
Determine that pump X needs updated settings 518
Transmit updated settings 520
Update settings 522

FIG. 5

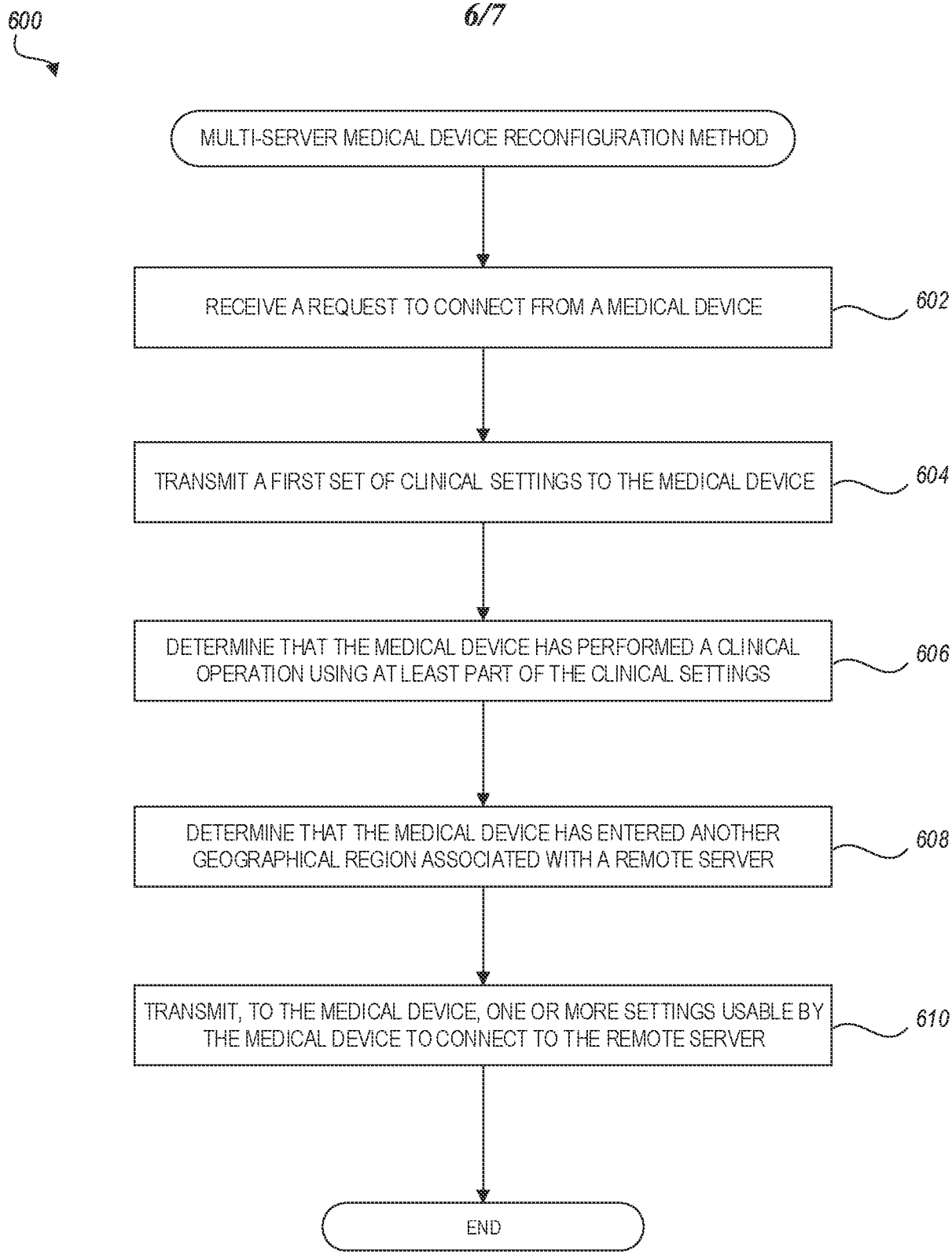
600
MULTI-SERVER MEDICAL DEVICE RECONFIGURATION METHOD
RECEIVE A REQUEST TO CONNECT FROM A MEDICAL DEVICE
602
TRANSMIT A FIRST SET OF CLINICAL SETTINGS TO THE MEDICAL DEVICE
604
DETERMINE THAT THE MEDICAL DEVICE HAS PERFORMED A CLINICAL OPERATION USING AT LEAST PART OF THE CLINICAL SETTINGS
606
DETERMINE THAT THE MEDICAL DEVICE HAS ENTERED ANOTHER GEOGRAPHICAL REGION ASSOCIATED WITH A REMOTE SERVER
608
TRANSMIT, TO THE MEDICAL DEVICE, ONE OR MORE SETTINGS USABLE BY THE MEDICAL DEVICE TO CONNECT TO THE REMOTE SERVER
610
END

FIG. 6

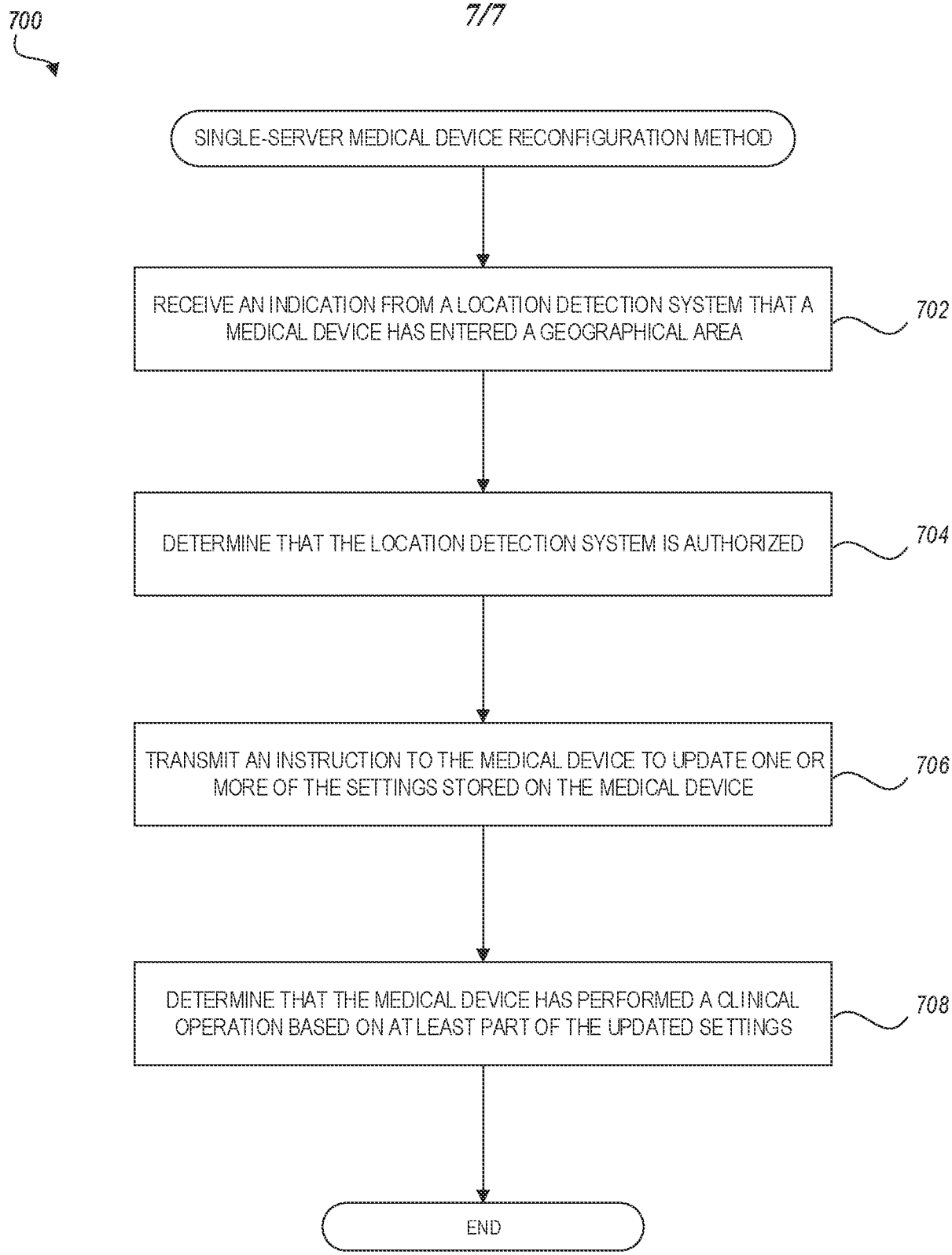
700
SINGLE-SERVER MEDICAL DEVICE RECONFIGURATION METHOD
RECEIVE AN INDICATION FROM A LOCATION DETECTION SYSTEM THAT A MEDICAL DEVICE HAS ENTERED A GEOGRAPHICAL AREA
702
DETERMINE THAT THE LOCATION DETECTION SYSTEM IS AUTHORIZED
704
TRANSMIT AN INSTRUCTION TO THE MEDICAL DEVICE TO UPDATE ONE OR MORE OF THE SETTINGS STORED ON THE MEDICAL DEVICE
706
DETERMINE THAT THE MEDICAL DEVICE HAS PERFORMED A CLINICAL OPERATION BASED ON AT LEAST PART OF THE UPDATED SETTINGS
708
END

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 21/39457

A. CLASSIFICATION OF SUBJECT MATTER

IPC - A61K 9/22, G06F 17/00 (2021.01)

CPC - G16H 20/17, A61M 5/142, G16H 40/63, G16H 40/40, A61M 2205/18, A61M 2205/3553

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 2017/0258401 A1 (ZOLL Medical Corporation) 14 September 2017 (14.09.2017), entire document especially abstract; para [0011]-[0015], [0016], [0034], [0044], [0052]-[0063], [0066], [0086]-[0093], [0106], [0114], [0116]	5, 6, 8-14, 16-20 ---------- 1-4, 7, 15
Y	US 2011/0028885 A1 (Eggers et al.) 03 February 2011 (03.02.2011), entire document especially para [0053]-[0056], [0069]	1-4, 7, 15
A	US 2008/0033361 A1 (Evans et al.), 07 February 2008 (07.02.2008), entire document	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 September 2021 (13.09.2021)	OCT 13 2021
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Kari Rodriquez Telephone No. PCT Helpdesk: 571-272-4300